DECIPHERING THE CONTROL ARCHITECTURE OF VOLUNTARY MOVEMENTS

Motile animals can produce a wide repertoire of skilled movements. The motor system that helps in generating these movements are inherently noisy like any other biological system. Even then, humans are exceptionally good at their motor skills. It raises an important question of: “What is the control mechanism that maintains the motor performance despite the noise?” One way to study these mechanisms is to study motor behaviour. In this talk, I will discuss how we can use the natural variability in repeated movements made by humans, as a tool for understanding the basic principles underlying the motor system. We use a particular kind of voluntary movement called saccades along with concepts from control systems theory to probe into interesting questions about the control architecture behind these movements.

Saccades are rapid ballistic eye movements which happen without the use of sensory feedback. Hence, they are largely thought to be pre-programmed and controlled by a feedforward system from optimal control theory point of view. But there are various experimental studies with mid-flight correction of saccades produced by blink perturbations, TMS perturbations and target jump experiments; suggesting that these movements are continuously monitored by internal feedback. It raises an obvious question of whether normative saccades could also be using such mechanism. Specifically, my research aims to address three questions underlying the control of saccadic eye movements. First, could inter-trial variability in saccades reveal the presence or absence of internal feedback mechanism? Secondly, what is the type of internal feedback information used in saccade generation and thirdly to study the control architecture of oblique saccades by using variability of saccades. In my talk I will provide evidence suggesting that normative saccades are under the monitoring of internal feedback and in the second part of my talk I will provide results suggesting the use of both velocity and displacement information as internal feedback.

I anticipate that studying how biological systems produce accurate movements in the presence of noise would provide the information required to engineer artificial systems that are as effective as human system in producing flexible but highly accurate movements from imprecise elements. I also hope such engineered systems with built in biological constraints would better integrate with patients having movement disorders to improve their motor coordination.